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ACEA SPECIFIKACIJE MOTORNIH ULJA

Sažetak

ACEA (Association des Constructeurs Européens d'Automobiles) predstavlja udruženje europskih konstruktora vozila, koje je 1991. godine naslijedilo prijašnji CCMC (Comité des Constructeurs d'Automobiles du Marché Commun) i preuzelo CCMC-ove specifikacije. Prve ACEA specifikacije za motorna ulja izdane su krajem 1995. godine pod oznakom ACEA European Oil Sequences 1996.

Specifikacije definiraju minimalne kvalitetne razine motornih ulja za servisno punjenje benzinskih motora, lako opterećenih dizelovih motora (osobna vozila) i teško opterećenih dizelovih motora (gospodarstvena vozila). ACEA specifikacije zahtijevaju da su svi rezultati motornih ispitivanja primjenskih karakteristika ulja dobiveni u skladu sa sustavom osiguranja kvalitete europskih motornih ulja – EELQMS (European Engine Lubricants Quality Management System).

Nakon ACEA-e 1996. slijedila su nova izdanja specifikacija motornih ulja ACEA 1998. te zatim ACEA 1999. Najnoviji nacrt ACEA 2002. specifikacija motornih ulja (draft 7.1a) objavljen je u rujnu 2001. g. Sa stajališta proizvođača motornih ulja ACEA specifikacije su donijele značajne promjene u razvoju motornih ulja time što su strogo definirale postupke ispitivanja pri promjenama ili baznog ulja ili poboljšivača indeksa viskoznosti u formulaciji motornog ulja.

UVOD

Međunarodno prihvaćene specifikacije motornih ulja služe proizvođačima motora i vozila, proizvođačima maziva, proizvođačima aditiva te korisnicima motornih ulja. Specifikacije su temeljene na odgovarajućim ispitnim

postupcima (testovima), koji su razvijeni na reprezentativnim motorima, referentnim gorivima i uljima. Sustav osiguranja kvalitete osigurava preciznost testova kao i pouzdanost i vjerodostojnost ispitnih rezultata.

Komitet konstruktora vozila Europskog zajedničkog tržišta CCMC (Comité des Constructeurs d'Automobiles du Marché Commun) razvio je kasnih sedamdesetih godina prve specifikacije temeljene na izabranim CEC (Coordinating European Council for the Development of Performance Tests for Lubricants and Engine Fuels) i ASTM (American Society for Testing and Materials) motornim testovima. Ranih osamdesetih godina CCMC je klasificirao motorna ulja prema radnim svojstvima:

- G1, G2, G3 / 1983. – ulja za benzinske motore
- D1, D2, D3, PD1 / 1984. – ulja za dizelove motore gospodarstvenih i osobnih vozila
- G4, G5, D4, D5, PD2 / 1989. – ulja za benzinske motore, dizelove motore gospodarstvenih i osobnih vozila
- G4, G5, D4, D5, PD2 / 1991. – ulja za benzinske motore, dizelove motore gospodarstvenih i osobnih vozila

U veljači 1991. formirano je Udruženje europskih konstruktora vozila ACEA (Association des Constructeurs Européens d'Automobiles), koje je naslijedilo prijašnji CCMC i preuzelo CCMC-ove specifikacije. Članovi ACEA-e su: BMW, DAF, Fiat/Iveco, Ford, MAN, Mercedes-Benz, Opel, PSA, Renault, Rover, Saab-Scania, Volkswagen i Volvo.

Budući da je postalo jasno da su stare CCMC specifikacije neadekvatne glede novog razvoja motora, članovi ACEA-e su stoga odlučili da razviju nove programe ispitivanja kako bi udovoljili zahtjevima modernih motora, koristeći odgovarajuće međunarodno provjerene postupke ispitivanja. U razvoj ACEA specifikacija bila je uključena i industrija maziva kao i industrija aditiva svojim organizacijama ATIEL (Association Technique de l'Industries Européenne des Lubrifiants) i ATC (Technical Committee of Petroleum Additive Manufacturers).

ACEA SPECIFIKACIJE

Novi europski sustav klasifikacije i specifikacija motornih ulja prema radnim svojstvima ulja (ACEA European Oil Sequences 1996.) objavljen je u prosincu 1995. godine. Sustav definira minimalne kvalitetne razine motornih ulja za servisno punjenje benzinskih motora, lako opterećenih dizelovih motora i teško opterećenih dizelovih motora. Označavanje kvalitetnih razina motornih ulja je slijedeće: Svaka klasa je označena slovom (A, B ili E) i podijeljena na više kategorija koje su označene brojkom (1,2,3..). U dodatku se nalazi dvoznamenkasti broj, koji označava godinu uvođenja kvalitetne razine. U oznaku može biti uključen i broj izdanja, ako su zahtjevi ažurirani ali bez promjena u oštrini testova.

ACEA 1996.

1. motorna ulja za benzinske motore
   - A1, A2, A3 – 96
2. motorna ulja za lako opterećene dizelove motore (osobna vozila)
   - B1, B2, B3 – 96
3. motorna ulja za teško opterećene dizelove motore (gospodarstvena vozila)
   - E1, E2, E3 – 96

Zbog zahtjeva za sve strožom kontrolom emisije ispušnih plinova te zahtjeva korisnika u pogledu povećanja iskoristivosti vozila i smanjenja operativnih troškova, ACEA specifikacije motornih ulja doživjele su još 2 izdanja 1998. i 1999. godine.

ACEA 1998.

1. motorna ulja za benzinske motore
   - A1–98, A2–96 issue 2, A3–98
2. motorna ulja za lako opterećene dizelove motore (osobna vozila)
   - B1, B2, B3, B4 – 98
3. motorna ulja za teško opterećene dizelove motore (gospodarstvena vozila)
   - E1–96 issue 2, E2–96 issue 2, E3–96 issue 2, E4–98

ACEA 1998. specifikacije uvele su promjene u dvije kategorije motornih ulja za benzinske motore (A1–98, A3–98), u svim kategorijama motornih ulja za dizelove motore osobnih vozila uz uvođenje nove kategorije za dizelove motore s direktnim ubrizgavanjem goriva (B4–98), te uvođenje nove kategorije motornih ulja za visokoučinkovite dizelove motore gospodarstvenih vozila koji zadovoljavaju Euro 3 zahtjeve emisije ispušnih plinova (E4–98).

ACEA 1999.

1. motorna ulja za benzinske motore
   - A1–98, A2–96 issue 2, A3–98
2. motorna ulja za lako opterećene dizelove motore (osobna vozila)
   - B1, B2, B3, B4 – 98
3. motorna ulja za teško opterećene dizelove motore (gospodarstvena vozila)
   - E2–96 issue 3, E3–96 issue 3, E4–99, E5–99

ACEA 1999. specifikacije donijele su promjene samo u klasi motornih ulja za dizelove motore gospodarstvenih vozila. Brisana je kategorija E1–96 issue 2, promijenjena kategorija E4–98 u E4–99 te uvedena nova kategorija E5–99. Slijedi opis ACEA kvalitetnih razina motornih ulja:

Motorna ulja za benzinske motore

A1 Ulje namijenjeno za uporabu u benzinskim motorima, koji su posebno konstruirani za uporabu ulja niske viskoznosti koja štede gorivo i čija se HTHS viskoznost kreće između 2.9 i 3.5 mPa·s. Ovo ulje može biti neprikladno za uporabu u nekim motorima.

A2 Ulje namijenjeno za uporabu u većini benzinskih motora s normalnim razdobljem zamjene ulja, premda može biti neprikladno za uporabu u nekim visokoučinskim motorima.

A3 Ulje visoke smične stabilnosti namijenjeno za uporabu u visokoučinskim benzinskim motorima, kao i za produžena razdoblja zamjene ulja, odnosno za teže uvjete eksploatacije prema preporukama proizvođača motora.

Motorna ulja za lako opterećene dizelove motore (osobna vozila)

B1 Ulje namijenjeno za uporabu u dizelovim motorima osobnih automobila i lakih dostavnih vozila, kod kojih je konstrukcijski omogućena uporaba ulja niske viskoznosti koja štede gorivo i čija se HTHS viskoznost kreće između 2.9 i 3.5 mPa·s. Ovo ulje može biti neprikladno za uporabu u nekim motorima.

B2 Ulje namijenjeno za uporabu u većini dizelovih motora (prvenstveno s indirektnim ubrizgavanjem goriva) osobnih automobila i lakih dostavnih vozila s normalnim razdobljem zamjene ulja, premda može biti neprikladno za uporabu u nekim visokoučinskim motorima.

B3 Ulje visoke smične stabilnosti namijenjeno za uporabu u visokoučinskim dizelovim motorima (prvenstveno s indirektnim ubrizgavanjem goriva) osobnih automobila i lakih dostavnih vozila, kao i za produžena razdoblja zamjene ulja, odnosno za teže uvjete eksploatacije prema preporukama proizvođača motora.

B4 Ulje namijenjeno prvenstveno za uporabu u dizelovim motorima osobnih automobila i lakih dostavnih vozila s direktnim ubrizgavanjem goriva.

Motorna ulja za teško opterećene dizelove motore (gospodarstvena vozila)

E1 Ulje namijenjeno za uporabu u teško opterećenim dizelovim motorima s normalnim punjenjem odnosno blagim pretpunjenjem, te s normalnim razdobljem zamjene ulja.

E2 Ulje namijenjeno za uporabu u većini teško opterećenih dizelovih motora s normalnim punjenjem odnosno pretpunjenjem, te s normalnim razdobljem zamjene ulja.

E3 Ulje namijenjeno za uporabu u dizelovim motorima, koji zadovoljavaju Euro 1 i Euro 2 zahtjeve emisije ispušnih plinova i rade pod teškim uvjetima eksploatacije, te za produžena razdoblja zamjene ulja prema preporukama proizvođača motora. Ovo ulje osigurava bolju čistoću klipa, smanjuje poliranje cilindra, trošenje dijelova motora i stvaranje čađi, te ima bolju oksidacijsku i termičku stabilnost.

E4 Ulje visoke smične stabilnosti namijenjeno za uporabu u visokoučinskim dizelovim motorima, koji zadovoljavaju Euro 1, Euro 2 i Euro 3 zahtjeve emisije ispušnih plinova i rade pod vrlo teškim uvjetima eksploatacije, te za značajno produžena razdoblja zamjene ulja prema preporukama proizvođača motora. Ovo ulje osigurava još bolju čistoću klipa, još više smanjuje trošenje dijelova motora i stvaranje čađe, te ima još bolju oksidacijsku i termičku stabilnost.

E5 Ulje visoke smične stabilnosti namijenjeno za uporabu u visokoučinskim dizelovim motorima, koji zadovoljavaju Euro 1, Euro 2 i Euro 3 zahtjeve emisije ispušnih plinova i rade pod vrlo teškim uvjetima eksploatacije, te za produžena razdoblja zamjene ulja prema preporukama proizvođača motora. Ovo ulje osigurava u odnosu na E3 kategoriju bolju čistoću klipa, smanjuje poliranje cilindra, trošenje dijelova motora i stvaranje čađi, te ima bolju oksidacijsku i termičku stabilnost.

ACEA specifikacije motornih ulja definiraju i zahtjeve laboratorijskih i motornih testova koje motorno ulje mora zadovoljiti.

Laboratorijski testovi su propisani za sve kategorije motornih ulja i obuhvaćaju:

- SAE J300 gradacije viskoznosti
- smičnu stabilnost
- dinamičku viskoznost kod visoke temperature pri velikom gradijentu smicanja, HTHS
- isparivost ulja (Noack)
- sulfatni pepeo
- pjenjenje
- pjenjenje kod visoke temperature
- kompatibilnost s elastomerima

Kategorija E5–99 motornih ulja za dizelove motore gospodarstvenih vozila ima još dva dodatna laboratorijska testa:

- oksidacijska stabilnost
- svojstva zaštite od korozije

Motorni testovi su također propisani za sve kategorije motornih ulja, ali su različiti za pojedine klase motornih ulja.

Motorni testovi za motorna ulja za benzinske motore

- Sequence IIIE – visokotemperaturna oksidacija
- TU3MH – visokotemperaturni talozi, zapečenje prstenova, zgušnjavanje ulja
- Sequence VE – niskotemperaturni talozi
- TU3MS – trošenje razvodnog mehanizma
- M111SL – crni talozi
- M111FE – ušteda goriva (samo za A1)

Motorni testovi za motorna ulja za lako opterećene dizelove motore (osobna vozila)

- VW 1.6 TCD – zapečenje prstenova, čistoća klipa
- XUD11ATE/BTE – disperzivnost na umjerenoj temperaturi
- OM602A – trošenje, stabilnost viskoznosti, potrošnja ulja
- VWDI – čistoća klipa, zapečenje prstenova (samo za B-4)
- M111FE – ušteda goriva (samo za A1)

Motorni testovi za motorna ulja za teško opterećene dizelove motore (gospodarstvena vozila)

- OM364LA – poliranje cilindra, čistoća klipa (za E-2, E-3)
- OM602A – trošenje
- Mack T-8/T-8E – čađa u ulju (za E-3, E-4, E-5)
- OM441LA – poliranje cilindra, čistoća klipa, talozi turbopunjača (za E-4, E-5)
- Cummins M11 – trošenje uzrokovano čađom (samo za E-5)
- Mack T-9 – trošenje cilindara, prstenova, ležajeva (samo za E-5)

Namjera ACEA udruženja bila je da njihove specifikacije motornih ulja budu opće prihvaćene od svih europskih proizvođača motora/vozila, tj. da pojedini proizvođači nemaju dodatne zahtjeve za kvalitetom motornog ulja. Nažalost, praksa je pokazala da do toga nije došlo, jer veliki broj proizvođača koji su čak članovi ACEA-e i danas ima svoj poseban sustav homologacije motornih ulja. Pri tome zahtjevi ACEA specifikacija predstavljaju samo temeljne zahtjeve na koje proizvođači motora i vozila nadograđuju svoje dodatne zahtjeve.

ACEA 2002. SPECIFIKACIJE – PRIJEDLOG

U programu rada ACEA udruženja bilo je predviđeno da se svake dvije godine izdaju nove specifikacije motornih ulja. Posljednje dvije godine proizvođači motora i vozila, članovi ACEA-e rade na usaglašavanju novih specifikacija. S obzirom na različite, a ponekad i kontradiktorne zahtjeve pojedinih članova, doživjeli smo neuobičajeno veliki broj nacrta (radnih

prijedloga) ACEA specifikacija. Posljednji nacrt ACEA specifikacija oznake ACEA 2002. draft 7.1a objavljen je u rujnu 2001.

ACEA 2002. draft 7.1a

1. motorna ulja za benzinske motore
   - A1–02, A2–96 issue 3, A3–02, A4–nn, A5–02
2. motorna ulja za lako opterećene dizelove motore osobnih vozila
   - B1–02, B2–98 issue 2, B3–98 issue 2, B4–02, B5–02
3. motorna ulja za teško opterećene dizelove motore gospodarstvenih vozila
   - bez promjena u odnosu na ACEA 1999.

Novi nacrt ACEA 2002. specifikacija obuhvaća samo motorna ulja za benzinske motore i dizelove motore osobnih vozila, dok za dizelove motore gospodarstvenih vozila nema nikakvog prijedloga. Iz navedenog nacrta vidljivo je da se osim promjena postojećih kategorija, predlažu i tri nove kategorije motornih ulja:

- A4-nn – rezervirano za benzinske motore s direktnim ubrizgavanjem goriva
- A5-02 – ulje visoke smične stabilnosti, namijenjeno za uporabu uz produžene intervale zamjene ulja u visokoučinskim benzinskim motorima, koji su posebno konstruirani za uporabu ulja niske viskoznosti koja štede gorivo i čija se HTHS viskoznost kreće između 2.9 i 3.5 mPa·s. Ovo ulje može biti neprikladno za uporabu u nekim motorima.
- B5-02 – ulje visoke smične stabilnosti, namijenjeno za uporabu uz produžene intervale zamjene ulja u dizelovim motorima osobnih automobila i lakih dostavnih vozila, kod kojih je konstrukcijski omogućena uporaba ulja niske viskoznosti koja štede gorivo i čija se HTHS viskoznost kreće između 2.9 i 3.5 mPa·s. Ovo ulje može biti neprikladno za uporabu u nekim motorima.

ACEA 2002. draft 7.1a predviđa promjene pri laboratorijskim i motornim testovima. Što se tiče laboratorijskih testova, pored promjena granica isparivosti ulja i promjene granica dinamičke viskoznosti kod visoke temperature pri velikom gradijentu smicanja za neke gradacije viskoznosti, uvode se novi zahtjevi za sadržaj sumpora, fosfora i klora (bez ograničenja) i bitno se mijenjaju zahtjevi za sadržaj sulfatnog pepela. Nove predložene granice za sulfatni pepeo su:

- 1.3 % – A1, A3, B1, B3
- 1.5 % – A2, A4, A5

- 1.6 % – B4, B5
- 1.8 % – B2

Treba napomenuti da metoda ispitivanja kompatibilnosti motornih ulja s elastomerima niti u ovom nacrtu nije konačno definirana, tj. i pored navedenih granica još uvijek je u fazi proučavanja.

U pogledu motornih testova, ACEA 2002. draft 7.1a uvodi sljedeće promjene:

- Sequence IIIE / F – izbacuje se (A1, A2, A3, A5)
- PSA TU5 – uvodi se radi ocjene kontrole stvaranja visokotemperaturnih taloga, zapečenja klipnih prstenova i ugušćivanja ulja (A1, A2, A3, A5)
- Sequence VG – zamjenjuje Sequence VE (A1, A2, A3, A5)
- XUD 11 BTE – promjene granica (B1, B4, B5)
- OM 602A – promjene granica (B1, B2, B3, B4, B5)
- VW DI – promjene granica (B4, B5)

Navedene promjene u ACEA 2002. specifikacijama dovest će do sljedećih promjena u formulacijama motornih ulja:

- još niža isparivost motornih ulja
- veća uporaba hidrokrekiranih i sintetičkih (PAO) baznih ulja
- bolja detergentno/disperzantna svojstva motornih ulja

Kategorije A5 i B5 posebno će stvarati probleme formulatorima motornih ulja zbog kombinacije zahtjeva visoke kvalitete ulja i zahtjeva za uštedom goriva.

SUSTAV OSIGURANJA KVALITETE

Važno je istaći da za razliku od prijašnjih CCMC specifikacija, ACEA specifikacije predviđaju i sustav za osiguranje kvalitete i udovoljavanje propisanim kriterijima. Proizvođači motornih ulja moraju dokazati sukladnost radnih karakteristika ulja pouzdanim podacima i kontroliranim ispitivanjima u ovlaštenim laboratorijima. Svi rezultati motornih ispitivanja, koji se koriste kao potpora zahtjevu za sukladnost s ACEA razinom kvalitete, moraju se utvrditi u skladu sa sustavom osiguranja kvalitete europskih motornih ulja EELQMS (European Engine Lubricants Quality Management System). Osim toga svi proizvođači motornih ulja moraju dokazati sukladnost s ATIEL Code of Practice što znači poštivanje propisanih normi o formuliranju i ispitivanju motornih ulja. Proizvodni pogon mora imati ISO 9002 certifikat kvalitete. EELQMS je obvezan za sve proizvođače motornih ulja, koji deklariraju da njihova ulja zadovoljavaju ACEA specifikacije.

ATIEL

ATIEL je udruženje europskih proizvođača maziva (Association Technique de l'Industries Européenne des Lubrifiants) koje je definiralo postupke proizvođača maziva pri deklariranju ACEA kvalitete svojih motornih ulja u dokumentu The ATIEL Code of Practice for Developing Engine Oils Meeting the Requirements of the ACEA Oil Sequences. U tom dokumentu definirani su u originalnoj formulaciji motornog ulja i postupci pri promjeni:

- gradacije viskoznosti
- baznog ulja
- poboljšivača indeksa viskoznosti

U vezi promjene gradacije viskoznosti motornog ulja izrađene su tablice za svaki motorni test i različite gradacije viskoznosti motornog ulja. Iz tih tablica može se očitati da li pri promjeni određene gradacije viskoznosti treba ponoviti motorni test.

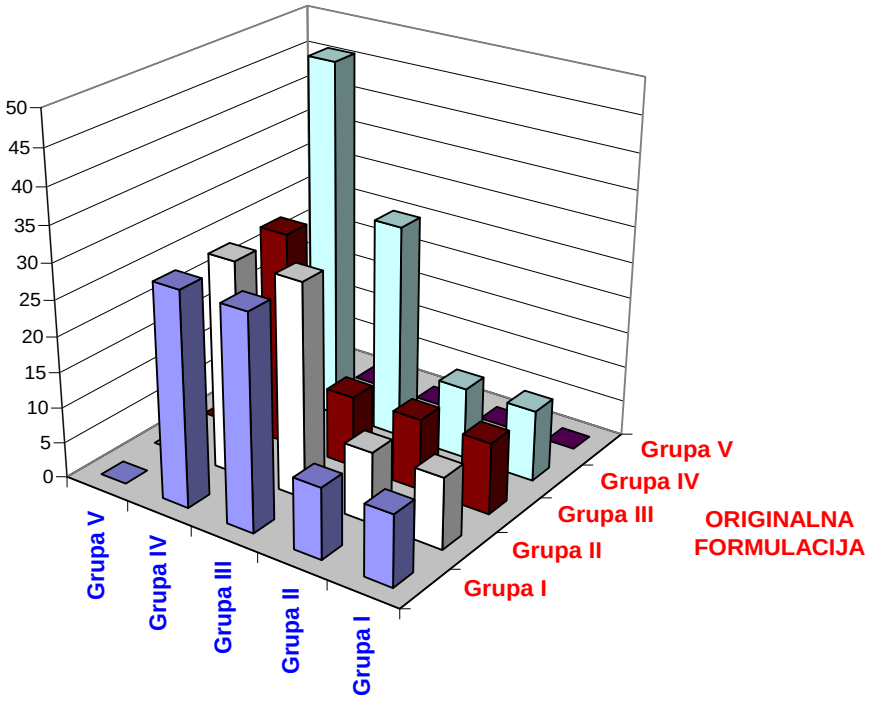
Bazna ulja koja se koriste u formulacijama motornih ulja, podijeljena su u 5 grupa (na temelju fizikalno-kemijskih svojstava):

- Grupa I – < 90 % zasićenih i/ili > 0.03 % S, IV = ≥ 80 < 120 (mineralna bazna ulja)
- Grupa II – ≥ 90 % zasićenih, ≤ 0.03 % S, IV = ≥ 80 < 120 (hidrotretirana bazna ulja)
- Grupa III – ≥ 90 % zasićenih, ≤ 0.03 % S, IV ≥ 120 (hidrokrekirana bazna ulja)
- Grupa IV – polialfaolefini (PAO)
- Grupa V – ostala bazna ulja (npr. esteri)Na temelju ove podjele baznih ulja definirane su maksimalne količine baznog ulja (u %) koje se mogu promijeniti u originalnoj formulaciji motornog ulja bez dodatnih motornih testova (tablica 1). Radi bolje preglednosti podaci iz tablice 1 prikazani su i na slici 1.

Tablica 1: Promjena baznog ulja
Table 1: Base oil change

Originalna formulacija	Grupa I	Grupa II	Grupa III	Grupa IV	Grupa V
Grupa I	10	10	30	30	0
Grupa II	10	10	30	30	0
Grupa III	10	10	10	30 (10-A)	0
Grupa IV	10	10	30 (10-A)	sva/all	0
Grupa V	0	0	0	0	0

Figure 1: Base oil change
Slika 1: Promjena baznog ulja



Poboljšivači indeksa viskoznosti podijeljeni su u dvije grupe:

- nedisperzantni
- disperzantni

U dokumentu The ATIEL Code of Practice for Developing Engine Oils Meeting the Requirements of the ACEA Oil Sequences definirani su, neovisno o tipu poboljšivača, dodatni motorni testovi koje treba provesti pri promjeni grupe poboljšivača indeksa viskoznosti u originalnoj formulaciji motornog ulja:

- nedisperzantni $\longrightarrow$ nedisperzantni
- nedisperzantni $\longrightarrow$ disperzantni
- disperzantni $\longrightarrow$ disperzantni

ZAKLJUČAK

1. ACEA specifikacije kontinuirano definiraju nove, više kvalitete motornih ulja.
2. ACEA specifikacije nisu se uspjele nametnuti kao jedini zahtjevi za motorna ulja; najveći proizvođači motora (vozila) i dalje imaju svoje specifikacije s dodatnim zahtjevima.
3. ACEA 2002 specifikacije još nisu definirane zbog različitih zahtjeva proizvođača motora (vozila).
4. EELQMS i ATIEL Code of Practice vrlo su otežali razvoj novih motornih ulja; to se naročito odnosi na manje proizvođače ulja koji su ujedno i proizvođači baznih ulja.

THE ACEA MOTOR OIL SPECIFICATIONS

Abstract

ACEA (Association des Constructeurs Européens d'Automobiles) represents an association of European vehicle designers. In 1991, it has taken over the role of the former CCMC (Comité des Constructeurs d'Automobiles du Marché Commun), inheriting their specifications in the process. The first ACEA motor oil specifications were issued towards the end of 1995, marked as ACEA European Oil Sequences 1996.

The specifications are defining minimal motor oil quality levels for the service filling of gasoline engines, light-duty diesel engines (passenger vehicles), and heavy-duty diesel vehicles (commercial vehicles). The ACEA specifications require that all the results of oil performances engine testing obtained be in keeping with the European Engine Lubricants Quality Management System (EELQMS).

After ACEA 1996, new editions of the ACEA motor oil specifications followed in 1998 (ACEA 1998), and 1999 (ACEA 1999). The latest ACEA 2002 motor oil specifications draft (draft 7.1a) has been published in September, 2001. From the viewpoint of motor oil manufacturers, the ACEA specifications have brought considerable changes into motor oil development by strictly defining test procedures for changing either base oil or viscosity index improver in the motor oil formulation.

INTRODUCTION

Internationally recognized motor oil specifications are intended for engine and vehicle manufacturers, lubricant manufacturers, additive manufacturers, and motor oil users. The specifications are based on certain test procedures (tests), developed on representative engines, referential fuels and oils. The Quality Assurance system ensures the precision of tests, as well as the reliability and authenticity of the test results.

Le Comité des Constructeurs d'Automobiles du Marché Commun – CCMC, developed in the late 70's the first specifications based on selected CEC (Coordinating European Council for the Development of Performance Tests for Lubricants and Engine Fuels) and ASTM (American Society for Testing and

Materials) engine tests. In the early 80's, CCMC classified motor oils per their respective performances:

- G1, G2, G3 / 1983 – gasoline engine oils
- D1, D2, D3, PD1 / 1984 – oils for diesel engines of commercial and passenger vehicles
- G4, G5, D4, D5, PD2 / 1989 – oils for gasoline engines, diesel engines of commercial and passenger vehicles
- G4, G5, D4, D5, PD2 / 1991 - oils for gasoline engines, diesel engines of commercial and passenger vehicles

The Association des Constructeurs Européens d'Automobiles (ACEA) was established in February, 1992. It has taken over the role of the former CCMC and inherited its specifications. ACEA members are BMW, DAF, Fiat, Iveco, Ford, MAN, Mercedes-Benz, Opel, PSA, Renault, Rover, Saab-Scania, Volkswagen and Volvo.

Since it is quite clear that the old specifications are inadequate in view of new engine development, ACEA members have therefore decided to develop new testing procedures in order to meet modern engine requirements, using the appropriate internationally validated test procedures in the process. The development of ACEA specifications has included both lubricant and additive industries, through their respective organizations ATIEL (Association Technique de l'Industrie Européenne des Lubrifiants) and ATC (Technical Committee of Petroleum Additive Manufacturers).

THE ACEA SPECIFICATIONS

The new European system of motor oil classification and specification according to oil performances (The ACEA European Oil Sequences 1996) was published in December, 1995. The system defines minimal motor oil quality levels for the service fills of gasoline engines, light-duty diesel engines, and heavy-duty diesel engines. The labelling of the motor oil quality levels proceeds as follows: Each class is marked by a letter (A,B, or E) and split into several categories marked by numbers (1,2,3..). The extension comprises a two-digit number marking the quality level introduction year. The label may also contain issue number, if the demands have been updated, but without any change in test severity.

<u>ACEA 1996</u>

1. gasoline engines motor oils
   - A1, A2, A3 – 96
2. motor oils for light-duty diesel engines (passenger vehicles)
   - B1, B2, B3 – 96
3. motor oils for heavy-duty diesel engines (commercial vehicles)

- E1, E2, E3 – 96

Due to requests for an increasingly stringent exhaust gas emissions control and consumers' requests as to increasing vehicle usability and reduction of operational costs, the ACEA specifications were released also in 1998 and 1999.

ACEA 1998

1. gasoline engines motor oils
   - A1-98, A2-96 issue, A3 – 98
2. motor oils for light-duty diesel engines (passenger vehicles)
   - B1, B2, B3, B4 – 98
3. motor oils for heavy-duty diesel engines (commercial vehicles)
   - E1-96 issue 2, E2-96 issue 2, E3 –96 issue 2, E4-98

The ACEA 1998 specifications have introduced changes into two gasoline engine motor oil categories (A1-98, A3-98), into all categories of motor oils for diesel engines of passenger vehicles, with the introduction of a new diesel engine category with direct fuel injection (B4-98), and the introduction of a new motor oil category for high performance diesel engines of commercial vehicles meeting the Euro 3 exhaust gas emission requirements (E4-98).

ACEA 1999

1. gasoline engines motor oils
   - A1-98, A2-96 issue 2, A3 – 98
2. motor oils for light-duty diesel engines (passenger vehicles)
   - B1, B2, B3, B4 – 98
3. motor oils for heavy-duty diesel engines (commercial vehicles)
   - E2-96 issue 3, E3 – 96 issue 3, E4-99, E5-99

The ACEA 1999 specifications have brought changes only in the class of motor oils for diesel engines of commercial vehicles. The E1-96 issue 2 category was erased, the E4-98 changed into E4-99, and a new E5-99 category introduced. Follows the description of motor oil quality levels:

Motor oils for gasoline engines

A1 Oil intended for use in gasoline engines designed especially for the use of fuel-saving low viscosity oils, the HTHS high temperature-high shear viscosity of which ranges from 2.9-3.5 mPas. This oil may be unfit for use in some engines.

A2 Oil intended for use in most gasoline engines with normal oil fill intervals, although it may prove unfit for use in some high performance engines.

A3 High shear stability oil intended for use in high performance gasoline engines, as well as for extended oil fill intervals i.e. for heavier service conditions, according to manufacturer recommendations.

Motor oils for light-duty diesel engines (passenger vehicles)

B1 Oil intended for use in diesel engines of passenger vehicles and light-duty delivery vehicles, their design enabling the use of of fuel-saving low viscosity oils, the HTHS viscosity of which ranges from 2.9-3.5 mPas. This oil may prove unfit for use in some vehicles.

B2 Oil intended for use in most diesel engines (primarily with indirect fuel injection) of passenger vehicles and light-duty delivery vans with normal oil fill intervals, although it may prove unfit for use in some high performance engines.

B3 High shear stability oil intended for use in high performance diesel engines primarily with indirect fuel injection of passenger vehicles and light-duty delivery vans, as well as for extended oil fill intervals i.e. for more severe service conditions, according to manufacturer recommendations.

B4 Oil intended primarily for use in diesel engines of passenger vehicles and light-duty delivery vans with direct fuel injection.

Motor oils for heavy-duty diesel engines (commercial vehicles)

E1 Oil intended for use in heavy-duty diesel engines naturally aspirated and moderately supercharged and with normal oil fill intervals.

E2 Oil intended for use in most heavy-duty diesel engines naturally aspirated and moderately supercharged and with normal oil fill intervals.

E3 Oil intended for use in diesel engines meeting the Euro 1 and Euro 2 exhaust emission requirements, operating under heavy-duty conditions, as well as for extended oil fill intervals, according to engine manufacturer recommendations. This oil ensures better piston cleanliness, reduces cylinder liner polishing, engine parts wear and deposit generation, and has a better oxidation and thermal stability.

E4 High shear stability oil intended for use in high performance diesel engines meeting the Euro 1, Euro 2, and Euro 3 exhaust emission requirements, operating under extremely heavy-duty conditions, as well as for considerably extended oil fill intervals, according to engine manufacturer recommendations. This oil ensures an even better piston cleanliness, reduces cylinder liner polishing, engine parts wear and deposit generation even more, and has an even better oxidation and thermal stability.

E5 High shear stability oil intended for use in high performance diesel engines meeting the Euro 1, Euro 2, and Euro 3 exhaust emission requirements, operating under extremely heavy-duty conditions, as well as for extended oil fill intervals, according to engine manufacturer recommendations. This oil ensures – with regard to the E3 category - even better piston cleanliness, reduces cylinder liner polishing, engine parts wear and deposit generation, and has a better oxidation and thermal stability.

The ACEA motor oil specifications define the requirements of both laboratory and engine tests that a given motor oil needs to pass.

Laboratory tests are prescribed for all motor oil categories and encompass the following:

- SAE J300 viscosity grades
- shear stability
- HTHS dynamic viscosity at high temperatures and high shear gradients
- oil volatility (Noack)
- sulphated ash
- foaming
- foaming at high temperatures
- compatibility with elastomers

The E5-99 category of motor oils for diesel engines of commercial vehicles has another two additional laboratory tests:

- oxidation stability
- corrosion-related properties

Engine tests are also prescribed for all motor oil categories, but they are different for individual motor oil classes.

<u>Engine tests for gasoline engine motor oils</u>

- Sequence IIIE – high temperature oxidation
- TU3MH – high temperature sludge, ring sticking, oil thickening
- Sequence VE – low temperature sludge
- TU3MS – valve train wear
- M111SL – black sludge
- M111FE – fuel saving (only for A1)

<u>Engine tests for light-duty diesel engine motor oils (passenger vehicles)</u>

- VW 1.6 TCD - ring sticking, piston cleanliness
- XUD11ATE/BTE – dispersancy at moderate temperature
- OM602A – wear, viscosity stability, oil consumption
- VWDI – piston cleanliness, ring sticking (only for B-4)
- M111FE - fuel saving (only for A1)

Engine tests for heavy-duty diesel engine motor oils (commercial vehicles)

- OM364LA – cylinder polishing, piston cleanliness (for E-2, E-3)
- OM602A – wear
- Mack T-8/T-8E – oil sludge (for E-3, E-4, E-5)
- OM441LA – cylinder polishing, piston cleanliness, turbocharger sludge (for E-4, E-5)
- Cummins M11 – wear caused by sludge (only for E-5)
- Mack T-9 – cylinder, ring, and bearing wear (only for E-5)

The intention of the ACEA association was for its motor oil specifications to be generally accepted by all European engine/vehicle manufacturers i.e. for individual manufacturers not to have any additional requirements for motor oil quality. Unfortunately, practice has shown that this, however, hasn't occurred, for a large number of manufacturers, also beeing ACEA members, still to this very day have their own special motor oil approval systems. In this case, the ACEA specification requirements constitute only the basic requirements, expanded consequently by the vehicle/engine manufacturers' additional requirements.

THE ACEA 2002 SPECIFICATIONS – PROPOSAL

The ACEA association's operating programme envisages that every two years new motor oil specifications be issued. During the past two years, the ACEA members (engine/vehicle manufacturers) have been working on the co-ordination of new specifications. Given the different, and sometimes even contradictory requirements of respective members, there has been an unusually high number of ACEA specification drafts. The last ACEA specification draft marked "ACEA 2002 draft 7.1a" was published in September, 2001.

The ACEA draft 7.1a

1. gasoline engines motor oils
   - A1-02, A2-96 issue 3, A3 – 02, A4-nn, A5-02
2. motor oils for light-duty diesel engines (passenger vehicles)
   - B1-02, B2-98 issue 2, B3-98 issue 2, B4 – 02, B5-02
3. motor oils for heavy-duty diesel engines (commercial vehicles)
   - without change with regard to ACEA 1999.

The new draft of ACEA 2002 specifications encompasses only motor oils for passenger vehicle gasoline engines and diesel engines, while there is no proposal whatsoever when it comes to the commercial vehicles' diesel engines. It may be observed from the above draft that, apart from the change in the existing categories, three new motor oil categories are also being proposed:

- A4-nn – reserved for gasoline engines with direct fuel injection
- A5-02 – high shear stability oil, intended for use with extended oil fill intervals in high performance gasoline engines designed especially for low-viscosity oil use, fuel-saving, the HTHS viscosity of which ranges from 2.9-3.5 mPas. This oil may prove unfit for use in some engines.
- B5-02 high shear stability oil, intended for use with extended oil fill intervals in diesel engines of passenger vehicles and light-duty delivery vans, designed especially for low-viscosity oil use, fuel-saving, the HTHS viscosity of which ranges from 2.9-3.5 mPas. This oil may prove unfit for use in some engines.

The ACEA draft 7.1a envisages changes in both laboratory and engine tests. As regards the former, apart from the change in oil volatility limits and dynamic viscosity limits at high temperatures and high shear gradient for some viscosity grades, new requirements are being introduced for sulphur, phosphorous, and chlorine content (no limit), while sulphate ash requirements are considerably changed. The new proposed limits for sulphate ash are as follows:

- 1.3% - A1, A3, B1, B3
- 1.5% - A2, A4, A5
- 1.6% - B4, B5
- 1.8% - B2

We should mention that the method of testing the compatibility of motor oils with elastomers has not been finally set in this draft either i.e. even aside from the said limits, it is still under investigation. As regards engine tests, ACEA 2002 draft 7.1a introduces the following changes:

- Sequence IIIE/F – excluded (A1, A2, A3, A5)
- PSA TU5 – introduced for evaluating the control of high temperature sludge generation, piston ring sticking, and oil thickening (A1, A2, A3, A5)
- Sequence VG - replaces Sequence VE (A1, A2, A3, A5)
- XUD 11 BTE – limit changes (B1, B4, B5)
- OM602A – limit changes (B1, B2, B3, B4, B5)
- VWDI – limit changes (B4, B5)

The said changes in the ACEA 2002 specifications shall lead to the following changes in motor oil formulations:

- an even lower motor oil volatility
- an increased use of hydrocracked and synthetic (PAO) base oils
- better detergent/dispersant motor oil properties

The A5 and B5 categories shall be causing particular problems to oil formulators due to the combination of the requirements for high oil quality and those for fuel saving.

THE QUALITY ASSURANCE SYSTEM

It is important to point out that, unlike former CCMC specifications, the ACEA specifications envisage also a Quality Assurance system and meeting of the criteria set. Motor oil manufacturers must prove the consistency of oil performances by reliable data and controlled tests performed in certified laboratories. All engine test results used as support for the request for co-ordination with the ACEA quality level must be determined in compliance with the European Engine Lubricants Quality Management System (EELQMS).

Apart from that, all motor oil manufacturers must prove the meeting of the ATIEL Code of Practice, referring to the meeting of the standards prescribed on motor oil formulation and testing. The production plant has to have the ISO 9002 quality certificate. EELQMS is mandatory for all motor oil manufacturers claiming that their oils meet the ACEA specifications.

ATIEL

ATIEL is the Association of European Lubricant Manufacturers (Association Technique de l'Industrie Européenne des Lubrifiants) having defined lubricant manufacturer procedures while claiming the ACEA quality for their motor oils in the document entitled The ATIEL Code of Practice for Developing Engine Oils Meeting the Requirements of the ACEA Oil Sequences. The said document sets in the original motor oil formulation among other things the procedures when changing:

- viscosity grades
- base oil
- viscosity index improver

As regards the change of motor oil viscosity grade, tables were made for each engine test and the various motor oil viscosity grades. These tables make it possible to read across whether the engine test in question should be repeated when changing a given viscosity grade.

Base oils used in motor oil formulations have been classified into 5 groups (based on their physico-chemical properties):

- Group I - < 90% saturated and/or >0.03% S,IV = ≥ 80 < 120 (mineral base oils)
- Group II - ≥ 90% saturated, ≤ 0.03% S,IV = ≥ 80 < 120 (hydrotreated base oils)
- Group III - ≥ 90% saturated, ≤ 0.03% S,IV ≥ 120 (hydrocracked base oils)
- Group IV – polyalphaolefins (PAO)
- Group V – other base oils (e.g. esters)

Based on this base oil classification, maximum base oil volume has been defined (in %) that may be changed in original motor oil formulation without additional engine tests (Table 1). In order to be more observable, data from Table 1 are shown also on Figure 1.

Viscosity index improvers have been classified in two groups:

- non-dispersant
- dispersant

The document entitled The ATIEL Code of Practice for Developing Engine Oils Meeting the Requirements of the ACEA Oil Sequences defines – regardless of the improver type – additional engine tests to be performed when changing the viscosity index improver group in an original motor oil formulation:

- non-dispersant $\longrightarrow$ non-dispersant
- non-dispersant $\longrightarrow$ dispersant
- dispersant $\longrightarrow$ dispersant

CONCLUSION

1. The ACEA specifications are continually setting new, higher motor oil qualities.
2. The ACEA specifications were not successful in the attempt to become the only motor oil requirements: the largest engine and vehicle manufacturers still hold their own specifications with additional requests.
3. The ACEA 2002 specifications have not been defined yet due to different requirements on the part of engine and vehicle manufacturers.
4. EELQMS and ATIEL Code of Practice have in many ways rendered difficult the development of new motor oils: this particularly regards small-scale oil manufacturers who are also producing base oils.

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5) ACEA 2002. European Oil Sequences – draft 7.1a, Brussels, Belgium, 2001.
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